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PERSPECTIVE ESSAY

Beyond flood risk reduction: How can green infrastructure advance both social justice and regional impact?

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Abstract
Green infrastructure is being pulled in divergent directions. As climate impacts intensify, advocates are promoting larger, ecosystem-scale strategies to help mitigate flood risks. Yet, research on existing urban greening projects finds that they can cause gentrification and displacement, suggesting that smaller projects may be more desirable from an equity perspective. This essay argues that cities need both large-scale and justice-enhancing nature-based solutions. They can help overcome tensions in these goals by (1) reframing green infrastructure as a way to support community development and integrated socio-ecological landscapes, and (2) advancing metropolitan regional governance strategies that alleviate municipal fiscal imperatives to maximize local land development. These proposals suggest that the practice of green infrastructure would benefit from diversifying its ranks to include social and government policy, community development, and agroecology, as well as learning from the Global South and those currently positioned as "off the map" of technical expertise. They also point to the need for interdisciplinary research that provides an evidence base for more transformative social, ecological, and governance strategies. While the essay focuses on the US context, it is relevant to an international audience given that similar challenges confront cities worldwide and that it highlights how the Global North can learn from the Global South.

Keywords Green infrastructure · Nature-based solutions · Flooding · Climate adaptation · Governance · Equity

1 Green infrastructure at a crossroads

For decades, cities have implemented smaller-scale green infrastructure projects, such as green roofs, rain gardens, and bioswales, to mitigate stormwater pollution and urban heat islands (Escobedo et al. 2019; Gill et al. 2007; Meerow and Newell 2017). Now, as cities struggle with climate impacts and decreased permitting for shoreline hardening (Dyckman et al. 2014, pp. 216–217), many environmental and government groups are advocating larger-scale green infrastructure, such as sand dunes, restored floodplains, and wetlands, to reduce urban flood risk (Carter et al. 2018; FEMA 2020, pp. 6, 8; Liao 2019; Matthews et al. 2015; Opperman 2014; Spalding et al. 2014). Meanwhile, critical urban scholars argue that governments and developers are using urban greening projects to boost property values and dispossess already disadvantaged groups (Anguelovski et al. 2019a, b; Blok 2020; Brand and Baxter 2020; Dooling 2009; Garcia-Lamarca et al. 2019). From household-level projects to reduce stormwater runoff in Philadelphia to urban greenbelts that reduce landslide risk in Medellín, green resilience infrastructure projects have contributed to historic processes of marginalization (Anguelovski et al. 2019a, b; Shokry et al. 2020). This has led some academics to advocate smaller-scale projects that are "just green enough" (Curran and Hamilton 2017, 2020; Wolch et al. 2014).

Both seemingly divergent aspirations are necessary—cities need large-scale physical transformations to cope with the magnitude of climate impacts *and* they need to promote social justice and equity (Goh 2020, p. 188). The critical question is how to advance on both fronts. In this essay, I argue that green infrastructure for flood risk reduction (GI-FRR) can help achieve these contrasting goals if its framing, design, and implementation address underlying drivers of unsustainable urban development in flood-prone areas and urban spatial inequality. In the following sections, I first describe how GI-FRR is consistent with neoliberal modes of governance that simultaneously expect cities to deliver landscape-scale benefits while requiring them to compete

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for funding and development. I then discuss how municipal fiscal reliance on growth and racist and capitalist development histories inhibit this approach from advancing more equitable and ecologically sustainable goals. In response, I offer propositions for future directions in research and practice, drawing on concepts of community development from the Global South and historic precedents in US regional environmental governance. These include focusing on local livelihoods and productive landscapes, and strengthening watershed-scale planning and governance institutions that would cross the organizational, administrative, and fiscal silos that currently preclude systems-based, integrated, and cumulative assessments, plans, and projects (Berke et al. 2018).

While this essay focuses on the US context, the need for GI-FRR projects to grapple with the tensions between scale and equity affects many cities worldwide. The compounding climate, health, Black Lives Matter, and economic crises that have erupted in 2020 compel scholars and practitioners to question how current strategies are complicit in and impacted by these dynamics. These crises invite us to holistically reimagine alternatives that conceive of GI-FRR not as a single-purpose technology but a path to more transformative socio-ecological relationships (Anguelovski et al. 2020).

2 GI-FRR as neoliberal urban environmental governance

Green infrastructure belongs to a suite of terms and strategies using natural or modified systems to provide human and ecosystems benefits. These strategies have been around since the dawn of human civilization, with ecosystems services, nature-based solutions, and green infrastructure serving as the most recent descendants (Cohen-Shacham et al. 2016; Samora-Arvela et al. 2017). The term "nature-based solutions" is associated primarily with international development settings and focuses on conservation, human livelihoods, and community-based development (Colls et al. 2009). Despite some overlap, "green infrastructure" (also known as sponge city, green–blue infrastructure, engineering with nature, and low-impact development) focuses more on reducing urban pollution and natural hazards (EPA 2015).

In the USA, green infrastructure—promulgated since the 2000s[1] to manage cities' stormwater pollution and urban heat island effects (Gill et al. 2007; Lennon 2015; Lowe et al. 2009; Tzoulas et al. 2007)—is attracting new interest as a way to cope with increasing flood risks (Carter et al. 2018; Matthews et al. 2015; Seddon et al. 2020). An estimated 13–15 million people live in flood-prone areas, with as much as $106 billion of real estate at risk of chronic flooding by 2050 (Flavelle et al. 2020; Houser et al. 2015; USGCRP 2018, p. 330). Meanwhile, many states now restrict new shoreline hardening projects like seawalls, bulkheads, and dykes due to their environmental impacts, yet lack the political will or financial capacity to engage in managed retreat or relocation (Dyckman et al. 2014, pp. 216–217). As a result, green infrastructure presents a politically palatable option to replace seawalls with sand dunes within existing epistemological, operational, and governance structures. Two-thirds of strategies listed in a recent Federal Emergency Management Agency (FEMA) guide on nature-based solutions are at the landscape scale, such as restoring or protecting wetlands, creating greenways, conserving land, restoring floodplains, creating stormwater parks, vegetating sand dunes, and rebuilding oyster reefs (FEMA 2020, p. 6, 8). Prominent built examples include Hunter's Point South Park (a floodable grass park with an acre of wetland) in New York City; dune restoration in beachfront towns like Long Beach, New Jersey; the Oro Loma horizontal levee south of Oakland, California that uses wetlands to treat wastewater and provide habitat; and (more unusually) the US$50 billion state-led Southern Louisiana Master Plan that seeks, *inter alia*, to divert sediment from channel dredging to elevate sinking wetlands.

Implementation of GI-FRR bears the hallmarks of contemporary neoliberal governance: deregulation, devolved environmental governance to the local level, competitive urban entrepreneurialism, financialization of real property benefits from flood risk mitigation, and techno-rational planning without attention to socio-spatial inequality (Castree 2008; Ciplet and Roberts 2017; Sager 2011). There is no US green infrastructure policy, though federal agencies like FEMA, the Environmental Protection Agency (EPA), and the Department of Transportation (DOT) provide grants or allocate funds to pay for green infrastructure projects (EPA 2015; Samora-Arvela et al. 2017, p. 180).[2] Instead,

[1] In the early 2000s, the US EPA, environmental groups, and water utilities began to popularize green infrastructure and low-impact development to reduce inland stormwater pollution under the Clean Water Act (Gill et al. 2007; Lennon 2015; Lowe et al. 2009). Famous early examples include Chicago's green roof program, Seattle and Portland's urban and suburban bioswales retrofits, and Los Angeles, Chicago, and New York's commitments to plan a million trees.

[2] Europe, by contrast, has taken a more government-led approach, with the European Commission funding a Green Infrastructure Working Group in 2011, advancing nature-based solutions as an economic innovation strategy in 2015, and dedicating €120 million for Nature-Based Solutions and Re-Naturing Cities under its Horizon 2020 Framework Programme for Research and Innovation (Davis et al. 2018; Samora-Arvela et al. 2017). Many member states now explicitly cite nature-based solutions in national policies, although the EU has yet to require members to implement them (Davis et al. 2018, p. 5).

agencies encourage municipalities to voluntarily adopt GI-FRR practices, even though they involve landscape-scale interventions that can take up a large portion of a municipality's land and extend across multiple jurisdictions. The co-benefits of reduced hazard risks include community health, recreation, and—importantly—increased property values and taxes for those who remain (FEMA 2020, pp. 11–13). This can help pay for the new bonds, taxes, and fees that cities must levy to pay for these infrastructure investments. This has the effect of committing cities to continue to develop sites just beyond current flood extents (Malecha et al. under review; Shi and Varuzzo 2020). Cities can also finance GI-FRR by competing for scarce state or federal funds or attracting private investment. The Rockefeller Foundation has funded numerous Rebuild by Design competitions in which design teams craft bold new GI-FRR and waterfront redevelopment schemes for cities.[3] These visual attestations of cities' commitment to resiliency market their continued attractiveness and competitiveness in the face of doomsday climate forecasts (Garcia-Lamarca et al. 2019).

As explored below, widespread implementation of GI-FRR is difficult due to the structural constraints facing local governments, but its scale-up is also undesirable if socially discriminatory outcomes persist. Historic governance characteristics have contributed to rising local spatial inequality and continued development in environmentally fragile areas. New visions of larger-scale GI-FRR projects—especially to grapple with climate-induced flooding later in the century—revive long-standing questions about the effectiveness and equity of urban land governance frameworks.

[3] After Hurricane Sandy in 2012, foundations and nongovernmental organizations like The Nature Conservancy helped ignite global imagination around GI-FRR (Opperman 2014). In 2013, the Rockefeller Foundation launched a Rebuild by Design competition to reimagine a resilient New York-New Jersey region under climate change. All winning entries dramatically re-naturalized the shoreline, most evocatively in the proposal for a new Meadlowlands National Park that restores and expands existing wetlands between the two states. This inspired similar competitions in Boston, Southern Louisiana, the San Francisco Bay Area, many also supported by the Rockefeller Foundation and similarly advocating green infrastructure. These proposals in turn have inspired international competitions like Designing Resilience in Asia in 2019. Competitions and transnational municipal and sustainability networks like the Rockefeller Foundation's 100 Resilient Cities, C40, ICLEI-Local Governments for Sustainability, and Dutch Delta Cities have popularized GI-FRR worldwide (Goh 2017; Woodruff 2018).

3 Municipal fragmentation and fiscal reliance on growth and development

The premise underlying GI-FRR—that local governments can shift their land use to large-scale environmental landscapes—runs counter to the underlying framework of municipal local development. Local governments in the USA rely on property taxes and user fees and charges, both of which require growth and development to sustain or grow local budgets (Chapman 2008; Kim 2017). Moreover, US metropolitan regions are fragmented into a hundred municipalities each, on average (Savitch and Adhikari 2016, p. 383), creating cities with relatively small footprints, each of which must fund itself with growth-based development. Many cities also incorporated into their own local government expressly to exclude minorities and avoid redistributing taxes, such that fragmentation has contributed to segregation and spatial inequality (Orfield 1997; Rothstein 2017).

Within this administrative reality, proponents of GI-FRR are rather naively asking cities to reduce flood risk by relocating residents from flood-prone areas, convert land zoned for development to land for green infrastructure, and expand the scale and space allotted to land-extensive dunes, wetlands, and restored floodplains. This conversion directly reduces revenue generation. As seen in shrinking and declining cities, this reduces the local capacity to maintain road, drainage, and water infrastructure, as well as provide social services like education and housing (Aldag et al. 2019). Many local governments therefore fear that leaving land green or converting developed sites back to undeveloped land will result in reduced tax revenues (BenDor et al. 2020, p. 11; Freudenberg et al. 2016, p. 30; Shi and Varuzzo 2020, p. 8). Historically, when balancing development needs and environmental risks, few cities have prioritized natural hazard risks in land use plans, despite growing awareness over the last 50 years (Burby 1998). Evidence suggests that local governments, especially if they are land constrained, have prevented residents from participating in federal floodplain property buyout programs, likely for this reason (Miao and Davlasheridze under review).

As a sign of cities' resistance to calls for GI-FRR and managed retreat, many cities are proceeding with waterfront or floodplain development alongside GI-FRR projects despite past flood events and cities' own climate adaptation and disaster risk assessments. In New York City, post-Sandy recovery efforts bought out neighborhoods on the east side of Staten Island, restoring some as coastal sand dunes, while advancing the island's North Shore Redevelopment with major new projects and one of the world's tallest Ferris wheels. Boston and its surrounding cities also have proposed shoreline greening solutions to mitigate flooding in existing neighborhoods and protect massive new waterfront

developments (Shi and Varuzzo 2020, p. 8). In 2017, the San Francisco Bay Area passed its first regional tax to support wetland restoration. But in one city on the bay, Cargill proposed to build a 12,000-unit development on top of a 1400-acre former salt pond. Southeast Florida's Regional Climate Change Compact is working with The Nature Conservancy to pilot restoration projects to reduce flooding and restore living shorelines, while also planning to accommodate another 3 million residents in one of the world's most vulnerable metropolises to sea-level rise (Seven50 2014; The Nature Conservancy 2014). According to the chief modeler of the region's Water Management District, planners continue to generate demographic projections that task water districts with providing the necessary supplies rather than asking how much the ecosystem can sustain and then adjusting population and consumption accordingly (Obeysekera, personal communication 2016). Green infrastructure is not appropriate everywhere, but these opposing waterfronts strategies are counterproductive if cities seek to increase coastal resilience.

Cities could do much more to coordinate their plans across agencies (Berke et al. 2018; Malecha et al. under review), although cities with a large percentage of land at risk of current or future flooding have little fiscal recourse beyond trying to build their way out or suffering a vicious cycle of disasters, declining property tax rolls, and disinvestment. Coordinating land use and fiscal redistribution across cities is that much harder given weak US regionalism. Regional institutions have never wielded strong multipurpose governmental authority in the USA. Nevertheless, over the past century, governance of environmental and natural resources has shrunk from federal, to state, to regional, to local levels and the private sector (Chapin 2012; Lemos and Agrawal 2009). Today, there are few governance institutions equipped to coordinate or integrate cross-sector and cross-jurisdiction responses to climate impacts (Shi 2019, p. 263). As a result, GI-FRR is likely to remain city-bound, contradictory, and uncoordinated even though, by definition, strategies require landscape-scale continuity to be effective.

4 GI-FRR as a new tool for capitalism's racist spatial fix under climate change

Effectively scaling-up GI-FRR projects, however, can have regressive impacts on frontline communities. Historically, green amenities and parks have been associated with higher property values and gentrification (Czembrowski and Kronenberg 2016; Immergluck and Balan 2018). A growing body of literature finds urban greening projects worldwide contribute to the displacement of vulnerable people (Anguelovski et al. 2016; Anguelovski et al. 2019a, b; Lamb 2019b; Pearsall 2018). GI-FRR exacerbates these dynamics. In Philadelphia, green resilient infrastructure siting corresponds to gentrification of census tracts with the highest Black and Hispanic populations (Shokry et al. 2020, p. 16). Houston controversially has proposed to exercise eminent domain to compel 400 low-income households to leave a flood-prone area and convert it to floodable green space, one of the first times the city has used this power with respect to flooding (Wade Interview 2020). From an administrative perspective, gentrification proximate to GI-FRR is a fiscal imperative to offset revenue losses associated with this land use. From a racial justice perspective, these projects use climate narratives and disasters to evict black and brown residents that cities long wanted to expel (Brand and Baxter 2020; Bullard and Wright 2009; Lamb 2019a). The fact that gentrification is such a big problem reflects the backlog of affordable housing confronting low- and lower-middle-income households.

These dynamics underscore how climate risk and adaptive responses provide America's racist capitalism with a new spatial fix (Harvey 2001; Taylor 2020). On the one hand, market internalization of climate risks is starting to devalue coast real estate and valorize lower-income communities that are inlands or upland, providing new opportunities for profitable urban development—buy low, sell high (Keenan 2019; Keenan and Bradt 2020). On the other hand, cities can invest in GI-FRR to protect low-lying communities, and price out lower-income residents and replace them with whiter and wealthier professional classes who are willing to pay for green amenities. Green infrastructure can directly and indirectly contribute to this two-step process of displacing disadvantaged groups and economically excluding them from sites of relative resilience (Shi forthcoming). Notably, a study of 400 parks in 10 US cities found that gentrification is associated with park qualities—greenways, strong transportation connections, downtown proximity, and location in Black or Latino communities, but not park size (Rigolon and Németh 2020, p. 402). This suggests that greenways' recreation and visual amenities more so than the amount of park impact local housing affordability.

Discourses in floodplain management are starting to attend to inequity and racial injustice (Mach et al. 2019, p. 6; Siders 2019). Grassroots and local government white papers have offered criteria and guidance for socially just climate adaptation projects, including prioritizing resilience investments in frontline communities (NAACP 2015; NACRP 2017). However, as the above examples suggest, targeting such communities for resources can lead directly to displacement (as in Houston) or indirectly through processes of gentrification (Anguelovski et al. 2019a, b; Blok 2020; Pearsall 2018). Scaling-up GI-FRR to landscape scales can exacerbate these trends by increasing the number of affected households, reducing supplies of affordable housing, and reducing municipal tax rolls and service quality. Equitable

green infrastructure for flood risk reduction, therefore, must not only prioritize marginalized communities for investments or resettlement, but also reimagine the approach to address intersectional challenges and structural drivers of inequity (Anguelovski et al. 2020; Shi 2020, p. 29).

5 Propositions to rethink green infrastructure for flood risk reduction

The year 2020 has seen unprecedented social mobilization against racism, escalating state and local fiscal crisis, and deepening household unemployment, poverty, and food insecurity. What does green infrastructure for flood risk reduction post-2020 look like if it is to achieve ecological benefits at scale, social justice, and fiscally functioning local governments? Below, I draw on past US and international developments to identify potential strategies to rethink GI-FRR. These propositions invite dialogue and creative problem-solving.

5.1 Connecting GI-FRR to urban agriculture and community development

Green infrastructure for flood risk reduction can support multiple social and ecological benefits when connected to food production, community development, and poverty alleviation. Research on ecosystem-based adaptation (EBA) and nature-based solutions (NBS) from the Global South as well as decades of community development efforts led by Black, Hispanic, and Indigenous communities provide a variety of strategies to broaden the imagination behind current GI-FRR. Growing support for urban food production that breaks down urban–rural spatial, economic, and class divisions complements these approaches (Vaarst et al. 2018). These strategies underscore the importance of building community capacity and co-production of learning.

The EBA and NBS projects of the Global South usually combine natural resource management, conservation, and restoration with livelihood diversification, learning from local knowledge, land tenure security, and control over decision-making (Ayers and Forsyth 2009; Jones et al. 2012; Munang et al. 2013). They not only seek to reduce natural hazard exposure and sensitivity to climate variability, but also enhance adaptive capacity through processes of learning, experimentation, and empowerment (Seddon et al. 2020, p. 6). Examples include mangrove conservation and restoration in Costa Rica, South Asia, and Southeast Asia to support local fisheries and reduce flood and tsunami risk; Bangladesh's Forestry, Fisheries, and Food program to support coastal adaptation with livelihood diversification, dykes, embankments, mangroves, and other plantations; and Japan's wetland restoration and adoption of winter-flooded rice paddies to support floodwater storage, migratory bird habitat, and agriculture (Cohen-Shacham et al. 2016, pp. 41, 64; Colls et al. 2009, p. 7; Rawlani and Sovacool 2011, p. 859). In a rare large-scale urban example, the 12,500-hectare East Kolkata Wetlands, a RAMSAR wetland conservation site, hosts fishponds and agriculture, treats a third of the city's sewage, sequesters carbon, controls flooding, and employs 50,000 people (Ramsar Sites Information Service 2002). As Rawlani and Sovacool found in their research on Bangladesh's Community-Based Adaptation through Coastal Afforestation project, "technology by itself is only a partial component of successful adaptation efforts, and … multiple and integrated adaptation measures that cut across sectors and social, institutional, and infrastructural dimensions are needed to truly build resilience and effectiveness" (2011, p. 845). Many of these projects learn from indigenous knowledge, build the capacity of women-led associations, help communities gain secure land tenure, and design landscapes that support livelihoods, biodiversity, and community development. These stand in sharp contrast to Global North projects that define multi-benefits as multiple environmental and hazard mitigation benefits, and that offer few social benefits or strategies for community empowerment (Cohen-Shacham et al. 2016, pp. 37, 45, 68; Colls et al. 2009, p. 11; Meerow and Newell 2017; Sussams et al. 2015).

Urban and peri-urban agriculture can reduce socio-economic vulnerability, productively use lands that cannot be built upon, and support wastewater and compost reuse (Dubbeling and Zeeuw 2010). The environmental benefits of agroecological systems have been under-explored (Vaarst et al. 2018, p. 704). A study of urban agriculture programs in six US cities finds that while they are not necessarily major sources of employment or tax generation, they are effective as a form of social enterprise that helps supplement incomes, build human and social capital especially among immigrants, refugees, and decarcerated people, and promote food security (Vitiello and Wolf-Powers 2014). On their own, these efforts do not produce "transformative wealth," but can promote economic stability and support workforce development, community building, and health outcomes (Vitiello and Wolf-Powers 2014, p. 519). For instance, community gardens have been central to community building, poverty alleviation, and food security in Rustbelt and declining city centers. Mobilization for environmental justice has involved not only opposition to siting polluting facilities in frontline neighborhoods (Bullard 2000), but also the use of community gardens to positively heal and promote community bonds and sense of place (Anguelovski 2014; Ranganathan and Bratman 2019). Native American Tribes have long used clam gardens to supplement local diets, support tribal traditions, and manage coastal erosion, practices now garnering national interest in the face of climate change (N. Jones 2020; Sadasivam 2020). Most such programs occupy

small footprints, such as vacant lots, and are run by and for youth and disadvantaged groups. Detroit's Hantz Farms provides a cautionary tale suggesting that scaling-up urban farming is justice enhancing only where it is owned by disadvantaged communities and advances justice goals.[4]

These examples highlight the possibility of GI-FRR experts learning from groups currently perceived as "off the map" of centers of scientific innovation. Scholars have argued that the Global South is not so much a geographic category, so much as a state of marginality that permeates northern and southern hemispheres (Miraftab and Kudva 2016). From this perspective, seeing from the "South" and peripheries of global metropoles holds critical learning opportunities for the "North." Rice and Burke observe that the "hegemony of liberal, wealthy environmental cosmopolitics" with its focus on recreation and conservation has stifled societal imagination for the possible sources and forms that sustainability efforts take (2018, p. 214). "Southern" perspectives of GI-FRR could respond to the exclusionary and often racist impacts of urban greening projects and enhance the long-term social benefits of these efforts.

5.2 Reviving platforms for watershed and regional governance

Ecosystem-scale strategies inevitably implicate metropolitan, watershed, or coastal zone governance in planning, coordinating, regulating, funding, and implementing such projects. As climate impacts accelerate over the course of the century, projects akin to the Southern Louisiana Master Plan will likely need to be deployed faster and in more places. Already, cities and states are recognizing the need for strengthening watershed management, and American history provides institutional precedents for large-scale initiatives. But GI-FRR must also address local fiscal imperatives if this approach is to avoid unsustainable and inequitable development. This requires intermunicipal and intergovernmental coordination, tax redistribution, and potentially redrawing boundaries to realign municipalities with shifting environmental landscapes.

American history provides numerous precedents for large-scale responses to ecosystem-scale hazards that are very different from contemporary approaches that ask every city to develop their own green infrastructure strategy. In the 1920s and 1930s, confronted with the Dust Bowl, President Franklin D. Roosevelt created the Prairie States Forestry Project, which funded workers and farmers to plant 220 million trees stretching 18,600 miles in a 100-mile wide band from Canada to Texas (Sauer 2010). Around the same time, the Soil Conservation Service worked with farmers and ranchers in the West and Midwest to conserve water and soil at an ecosystem scale (Helms 1990). In the 1970s, states adopted growth management policies to slow the consumption of agricultural and natural lands and created regional agencies to reduce pollution, manage flooding, and conserve coastal zones (Bollens 1992; Carruthers 2002; DeGrove 2005; Gale 1992). In the 1990s, the concept of integrated water resources management emphasized integrating spatial geographies, objectives across management goals, governance institutions, and time scales (Cardwell et al. 2006; Mukhtarov 2007). Many of these institutions have been watered down over time, dismantled, or defunded (Chapin 2012), but offer examples of institutions to revive.

Today, evidence suggests watershed planning for climate adaptation is resurgent. In 2013, Washington State's Department of Ecology, The Nature Conservancy, and Puget Sound Partnership created the Floodplains by Design program to reduce flood risk, restore salmon habitat, and preserve farmland, working closely with communities, Tribes, and farmers (WA DOE 2019). In 2020, Texas passed legislation mandating the division of the state into watershed basins and creation of regional flood management plans that feed into a statewide flood management plan. This is a break from past county-based flood control in the US state with the most flood-prone land and presidentially declared disasters (Ferguson 2019). Following the growing interest in metropolitan regional climate adaptation collaboratives nationwide (Shi 2019), the Resilient Mystic Collaborative in Metro Boston became one of the country's first watershed-scale adaptation collaboratives. It seeks to "prioritize, facilitate funding for, and implement cost-effective, multiple-benefit solutions that benefit the watershed as a whole through collective actions and/or site-specific interventions" (MRWA 2019). The Regional Plan Associations' 4th Regional Plan for the New York-New Jersey-Connecticut Metropolitan Area advocates the creation of a Regional Coastal Commission across the three states that creates and distributes an Adaptation Trust Fund (RPA 2017).

What these proposals do not yet do is grapple with the fiscalization of land use and redrawing of municipal boundaries. While politically untouchable now, it would be surprising if this were not considered given projections of sea-level rise and expanding floodplains. Could the municipal map of Southeast Florida remain unchanged with four feet of sea-level rise? However, fewer examples for metropolitan regionalism offer precedents for reforms under climate change. These include city–city and city–county consolidations, which are increasingly rare but have taken place where localities face fiscal stress or a crisis in infrastructure or

[4] In 2013, Detroit freely gave 20,000 acres of vacant land (with reduced property taxes) to millionaire John Hantz to develop the country's largest urban farm, ignoring the many community organizations and leaders who had invested decades of unpaid labor in community greening and farming. It is now a large-scale, commercial tree farm (Vitiello and Wolf-Powers 2014, pp. 511–512).

school districts that requires voters to approve the "nuclear" option. As another example, Minneapolis/St. Paul approved a regional tax in 1975 to incentivize development in the inner city and inner-ring suburbs, rather than subsidize exurban infrastructure expansion (Orfield 1997). Historically, pressures to regionalize have come from federal mandates or from local calls for reform (sometimes to sidestep federal mandates) (Barbour 2002). Federal and state funding for flood resilient infrastructure could be one way to incentivize local cooperation on land use, affordable housing, managed retreat, and GI-FRR rather than competing local grant applications. However, regional approaches can lend themselves to progressive or regressive political projects (Keil 2000). Moreover, while consolidation can in theory offer cost savings, efficiency, improved planning capacity, and greater authority to raise revenues, evidence is lacking or mixed (Carr and Feiock 2004; Swanstrom 2001). This calls for careful planning analysis to evaluate social, economic, and environmental impacts of regionalism under climate change. Much more research is needed to explore these options in relation to managed retreat, GI-FRR, and social justice.

6 Implications for practice and research

The use of green infrastructure for flood risk reduction is evolving but has yet to grapple with the historic political, institutional, and governance underpinnings of this approach. Ecologically functioning green infrastructure—unleashed rivers, sprawling wetlands—are inconsistent with the current governance landscape of fragmented local governments seeking to maximize local land values and minimize affordable housing. The design imagination for new ecological landscapes has far outpaced a reimagination of the new institutional and governance arrangements needed to enable nature-based solutions that advance social justice and ecological sustainability. Failure to address this gap can result not only in continued flood risk but also render green infrastructure a marketing device for cities to tout their climate and sustainability leadership without changing existing unsustainable and inequitable development practices (Garcia-Lamarca et al. 2019; Wachsmuth and Angelo 2018).

Growing societal awareness of the twin crises of climate change and social justice worldwide as well as newfound appreciation of the need for local and regional sustainability brought on by the COVID-19 pandemic create openings to consider innovative proposals that are both large-scale and justice-oriented. In this essay, I have argued that reimagining riparian or coastal landscapes as socio-ecological landscapes integrating human livelihoods, food production, and community development can disrupt long-standing "Northern" concepts separating urban and rural spaces, and conserved nature versus human settlement. Redrawing boundaries can help municipalities retreat, build on higher ground, and make way for ecologically restored landscapes. In so doing, cities have a chance to counteract historic patterns of municipal incorporation that sought to segregate and insulate local tax dollars from being shared with less privileged groups. These proposals build on past calls for green infrastructure to serve multifunctional purposes (Meerow and Newell 2017; Sussams et al. 2015) but like Goh (2020) emphasize attending to structural barriers and institutional reforms. Green infrastructure alone cannot change the past 500 years of human history but framing GI-FRR in relation to barriers to justice and sustainable development can contribute to goals of progressive reform.

For practitioners, this means opening the field to new participants from community development, Black, Hispanic, Tribal, and immigrant communities, race and gender studies, agriculture, and public health, among others. Domestic and international Indigenous groups, not just the Dutch, have lived with water for millennia in ways that marry local livelihoods, flood risk management, community governance, and spirituality. Privileging their knowledge, that of black communities who were among the first farmers of colonial America, or bringing in immigrant perspectives can expand the possibilities of green infrastructure and diversify, complement, and positively complicate current GI-FRR practices. Moreover, GI-FRR practitioners can engage those working in urban governance, administration, and activism to integrate nature-based solutions into federal and state-led policies over natural resource management, infrastructure funding, housing development, and local government fiscal policy.

This essay's proposals invite questions about feasibility and design that provide fertile ground for convergent research among practitioners, social scientists, ecologists, engineers, agriculture specialists, lawyers, public administrators, nonprofits, and community organizations. Researchers can build the evidence base that helps cities and advocacy groups assess what green infrastructure can realistically deliver (e.g., Ruckelshaus et al. 2016, p. 512), how much land might be needed to have GI-FRR protect urban settlements, what the impacts are to cities, and what configurations enable cities to expand GI-FRR. They can also help assess how much urban agriculture or aquaculture is feasible in urban settings as part of restorative landscapes given urban legacies of pollution, and how these might work economically, biologically, and organizationally. Together, such efforts can help transform green infrastructure from a tool for flood risk reduction to a pathway towards social and environmental justice.

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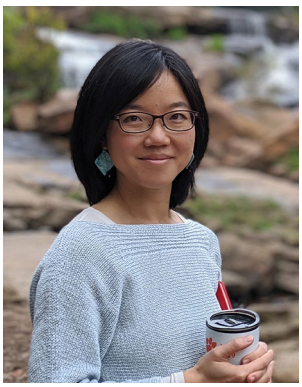

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